Combining activation technique and AMS for s-process measurements

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About half of the heavy elements above iron are produced in the slow neutron capture process (s-process). To understand this process, it is essential to obtain reaction cross sections under conditions corresponding to the respective astrophysical site. For the s-process, typical neutron energies are in the keV range.

Several activations with keV neutrons were performed at Karlsruhe Institute of Technology (KIT) in Germany [1]. Neutrons were produced by the reaction ^{7}Li(p,n) at the Karlsruhe 3.7 MV Van de Graaff accelerator. A quasistellar neutron spectrum could be produced, which approximates the Maxwellian distribution for kT = 30 keV.

These activations were followed by Accelerator Mass Spectrometry (AMS) at different facilities. The results were then compared to those of Time of Flight (ToF) measurements. The AMS results are systematically lower than the ToF results.

To investigate this discrepancy, a measurement at Frankfurt Neutron Source (FRANZ) in Germany [2] is planned to be performed this year. A neutron flux of about 10^{8} /cm^{2} /s will be provided by the reaction ^{7}Li(p,n) at the Van de Graaff accelerator. An activation using the same method as at KIT but with a different accelerator might reveal the reason for the systematic deviation between the AMS and ToF data. Subsequent AMS measurements will be performed at the 14 MV tandem accelerator of the Heavy Ion Accelerator Facility (HIAF) at the Australian National University in Canberra [3].

To complement the existing activations at kT = 30 keV, additionally several small samples are planned to be activated. Using small samples of milligramm order offers several advantages: more samples can be activated simultaneously and depending on sample positioning, different neutron energy spectra are covered within one activation. This way, a wider energy range of the s-process between about 10 and 100 keV can be reached.

In the future, FRANZ with its neutron flux up to 10^{12} /cm^{2} /s will be the most powerful neutron source in astrophysically relevant energy range [2]. Activation experiments at neutron flux this high combined with the AMS technique will tremendously improve the understanding of the astrophysical s-process.

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